volving axis, are suppressed for the sake of clearness. Under the condition of rapid rotation both disks appear to be coloured a uniform grey.

Thus in a single experiment is demonstrated (1) that blue and yellow are complementary colours, (2) that particular tones of blue and yellow produce by mixture of retinal impressions a white of low tint—in fact, by measuring the sectors composing the outer annulus, a white of 2-9ths the intensity of that of the annulus, which is produced by barium sulphate. Other binary combinations will be found to produce similar results, *e.g.* red and blue-green, violet and yellow-green. In fact given any hue, a second may be formed by means of this apparatus, such that the combination of the retinal impressions proper to each shall produce the sensation of white, the degree of this sensation varying with the tone of the constituents of the combination.

From the experimental investigation of complementary hues the definition of intensity is readily deduced. In the sectors of the plate we notice equality of area. Had we taken a fuller yellow of the same hue, the grey produced with the blue sector of equal area would have shown a yellow cast, and to restore the neutral grey or low white we must increase the area of the blue at the expense of the yellow. The relative intensity of complementary hues is thus defined to be the reverse of the sectors necessary to produce neutrality of hue.

The use of the particular yellow pigment of Fig. 1, coloured in the original chromate of lead, is dictated by the lowness of tints of all our blue pigments; the purest of our ultramarines, smalts, and aniline blues do not possess one-third the intensity of chromate of lead; and the same is true of the greens and violets.

The study of complementary colours leads directly to the discussion of the basis of this phenomenon, whether, *i.e.* it is physical or physiological? It is in this department of the subject that confusion of ideas has longest persisted. Although it was pointed out by M. Plateau as long ago as 1829 that the mixture of colouring-*matters* and of colour-*sensations* are distinct phenomena, the classical experiment of Muschenbroek, dating from 1762, is still retained by lecturers and text-books, together with erroneous interpretations. Newton himself fell into the same error in his discussion of the recombination of the spectral colours. The author puts the matter in the clearest light by pointing out that there are a number of mixtures producing the sensation of white light,—that psychological identity, therefore, is no criterion of physical identity.

The distinction is perhaps most clearly demonstrated by a plate of figures representing the superposed disks at rest and in motion. The outer annulus is composed of alternate and equal sectors of blue and yellow, the inner disk being coloured with a mixture of blue and yellow pigments in equal proportions. The distinction in appearance produced by motion affords the clearest demonstration of the point in question (Figs. 3 and 4).

The next portion of the treatise is devoted to the study of mixtures of colours, *i.e.* colour-sensations, which are not complementary. The more important results are those obtained in the so-called "degradation" of pigments. Such pigments, for instance, when applied to a white surface, will be more or less mixed with white, *i.e.* the sensations of white will be more or less conjoined with that of the pigment hue, as the quantity of pigment per unit of surface is less. The author reproduces series of such tones, in the case of Prussian blue and chrome yellow, together with their respective complementaries. In both cases it is found that the progression is accompanied by an alteration in hue, the fuller tones being distinctly redder. It is clear, therefore, that to construct a scale or gamut of tones with any given pigment, in order that this shall have an æsthetic or standard value, each tone must be referred to the same complementary, and the tones due to the pigment alone will need correction in accordance with their demonstrated imperfections, *i.e.* departures from the standards determined by the method of physiological comparison.

The author has very carefully compared such scales of tones with the purely arbitrary scales of M. Chevreul, and has found the differences to be considerable. Such indeed might be inferred indirectly from M. Chevreul's definition of "the tones of a colour"; they are, according to him, "the different degrees of intensity of which a colour is susceptible according as the *substance* by which it is produced (*représenté*) is pure or mixed with white."

A comparison of colour combinations harmonised according to the two systems, will show the æsthetic superiority of the physiological method, judged, that is, by the much abused arbiter, *taste*. It is unnecessary further to insist upon the practical importance of such conclusions. It will doubtless have been already appreciated on the part of the reader that the confusion of ideas which it is the object of this treatise to eliminate cannot have remained without influence upon the education of the eye; nor can he fail to see that the training involved in the practice of the author's experimental method is a valuable æsthetic discipline, as well as a precise study of colour relationships.

We have attempted to give an idea of the difference in appearance of the disks by lines on a white surface.

THE LATE FERDINAND VON HOCHSTETTER

THE numerous friends and admirers of the late Dr. Ferdinand von Hochstetter in Europe and Australasia have to thank his old associate, Dr. Julius von Haast, for a graceful tribute paid to his memory, which takes the form of a sympathetic biographical notice published towards the end of last August at Christchurch, New Zealand. The memoir, which is accompanied by two portraits, from a lithograph and a photograph showing the distinguished naturalist in his twenty-ninth and fiftieth years respectively, is taken for his early career partly from an account in Brockhaus's "Conversations Lexicon," and for the period since the two friends first met at Auckland, N.Z., in 1858, from Hochstetter's writings and private correspondence. Born on April 30, 1829, at Esslingen, Wurtemberg, the future naturalist was at first intended for the Church by his father, Prof. Christian Ferdinand Hochstetter, chief pastor of that town, and himself a botanist of no mean repute. But in the seminary of Maulbronn near Tübingen, his love of science, implanted in the paternal home, grew so strong that, besides theology, he applied himself with great zeal to the study of mineralogy, palæontology, and geology. After taking his degree of Doctor Philosophiæ in 1852 he seems to have finally made choice of a scientific career, and in 1853 found employment on the Geological Survey of the Austrian Empire, soon after receiving the appointment of Chief Geologist for the Bohemian Section. His reports on the geology of the Boehmer Wald were so highly appreciated that he was selected in 1857 as geologist of the *Novara* Expedition, which brought him to Auckland on December 22, 1858. Here his services were at once secured by the Government, and with the reluctant consent of the Commodore of the *Novara* he accepted an engagement of eight months to examine the geology, physical features, and natural history of New Zealand. During this period he made extensive topographical and geological surveys of the provinces of Auckland and Nelson, the results of which were embodied in his standard work, "Neu Seeland," published in 1863, followed in 1867 by the greatly enlarged English edition dedicated to the Queen. Soon after his return to Europe he was appointed Professor of Geology and Mineralogy in the Technical University of Vienna, and after a visit of some months to England in 1860 he settled permanently in the Austrian capital, where, in April 1861, he married

Georgina Bengough, daughter of the English director of the Vienna gas-works. A visit in 1863 to Vesuvius was followed next year by the appearance of the "Geology of New Zealand" and of the "Palæontology of New Zealand," both of great scientific value, and forming his main contributions to the extensive series of the *Novara* publications.

About the same time Hochstetter was commissioned to explore the lacustrine basins in Carinthia and other parts of Austria, where he discovered numerous remains of kitchen-middens and prehistoric lake dwellings similar to those found in the lakes of Switzerland. In 1867 he was elected President of the Imperial Geographical Society of Vienna, a position which he held till compelled by his failing health to resign it in 1882. He now commenced the publication of a whole series of geological and mineralogical text-books for higher schools, which were introduced into many parts of the Austrian Empire, and one of which, on crystallography, was especially distinguished by its clearness and thorough grasp of the subject. Time was now also found to complete his geological essays on the Cape of Good Hope, the Island of St. Paul, the Nicobars, and Java, for the *Novara* series, and also to publish an interesting account of the great earthquake and sea-wave of 1868, in the southern hemisphere, including a calculation of the mean depth of the Pacific deduced from the known velocity of the waves across that ocean. The appointment of Consulting Geologist to the Turkish Great Railway Company brought him in 1869 to the Balkan Peninsula, the results of which journey soon after appeared, partly in the *Proceedings* of the Vienna Geographical Society, partly in the *Year-Book* of the Imperial Geological Institute, and in *Petermann's Mittheilungen*. For these important geological surveys he was decorated by the Sultan with the order of the Mejidié. Notwithstanding the loss of his eldest daughter Julia in 1871, and a chronic affection of the throat, his scientific writings and surveys were now continued with unflagging zeal, including a handbook of geology which formed part of the "Allgemeine Erdkunde"; an atlas of twenty-four geological pictorial views, with letterpress; much harassing work in connection with the Viennese International Exhibition of 1873; and lastly, an arduous journey of over two months in the summer of 1872 to the Urals and Siberia as consulting geologist to a large mining association. Then came his honourable appointment as teacher of science to Crown Prince Rudolph in 1872, followed in 1875 by his election to the Rectorship of the Technical University, and in 1876 to the position of Imperial Intendant (Chief Curator) of the Imperial Austrian Museum of Zoology, Ethnology, and Natural History. He had hoped to witness the completion of this magnificent building, which has been in progress for many years; but, although it was nearly ready for occupation as early as the summer of 1881, he did not live to see it opened to the public. In the interests of the Museum he visited Denmark, Holland, Belgium, and North Germany in 1876, and was soon after busily engaged superintending excavations in Carinthia, Bohemia, and other parts of the empire, which resulted in the discovery of rich palæontological and archæological treasures, prehistoric burial-places, skeletons of the extinct cave bear, remains of fossil man, a large number of bronze ornaments, weapons, and implements. Towards the end of 1879 his health began to decline. He suffered much about this time from pains in the legs and arms, accompanied by sleeplessness and other symptoms which later developed into an incurable attack of diabetes, terminating on July 21 last a laborious and blameless life devoted entirely to the advancement of the natural sciences. Indefatigable to the last, he found time in the midst of his multifarious labours to issue a report in 1883 on some Mexican antiquities discovered by him in the Ambrose Collection in Tyrol, and which had originally been sent by Fernando Cortez to the Emperor Charles the Fifth. His last contribution to science was a paper read in February of the present year before the Vienna Geological Institute, giving an instructive account of the celebrated mineralogical collection now removed to the New Imperial Museum. Hochstetter's life may thus be described as an epitome of the history of the natural sciences in Austria during the last quarter of a century. Dr. von Haast's appreciative memoir concludes with the appropriate lines from Goethe:—

"Fest steh' dein Sarg in wohlgegönnter Ruh;
Mit lockrer Erde deckt ihn leise zu,
Und sanfter als des Lebens, liege dann
Auf dir des Grabes Bürde, guter Mann!"

NOTES

PROF. G. H. DARWIN, of Cambridge, and Prof. Daniel Oliver, of the Royal Gardens, Kew, have been nominated by the Council of the Royal Society for the award of the two Royal Medals conferred by the Crown. The Copley Medal is to be given to Prof. Carl Ludwig, of Leipzig, in recognition of the great services which he has rendered to physiological science. Prof. Tobias Robertus Thalén, of Upsala, is to have the Rumford Medal for his spectroscopic researches; and the Davy Medal is awarded to Prof. A. W. H. Kolbe, also of Leipzig, for his researches in the isomerism of alcohols. The two Leipzig Professors are Foreign Members of the Society. Prof. Darwin and Prof. Oliver are Fellows, the former well known for his mathematical investigations on the rigidity of the earth and on tides, the latter for his investigation of the classification of plants and for the important services which he has rendered to taxonomic botany.

IN speaking recently at the Academy of Music in Philadelphia to a large audience on the wave-theory of light, Sir William Thomson made the following remarks on the employment of the metrical system:—"You, in this country, are subjected to the British insularity in weights and measures; you use the foot, and inch, and yard. I am obliged to use that system, but I apologise to you for doing so, because it is so inconvenient, and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English Minister whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule, which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes. I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform."

IT is stated that Lord Rayleigh has resigned the Cavendish Professorship of Experimental Physics. The electors are Sir W. Thomson, Sir William (Justice) Grove, Profs. Liveing, Stokes, Darwin, R. B. Clifton (Oxford), and Stuart, and Mr. W. D. Niven.

DR. THOMAS WRIGHT, F.R.S., of Cheltenham, died on the night of Monday last. This sad announcement will be received with much regret by all who take interest in the progress of geology and palæontology. We hope to give some account of the deceased naturalist next week.